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**REMARKS**

Claims 1 through 30 are now pending in the instant patent application after entry of the above Amendment. Claims 1, 10, 11, 21 through 29, are the independent claims. Claims 2 through 9 depend from Claim 1. Claims 12 through 20 depend from Claim 11. Claim 30 depends from Claim 29. Claims 31 through 64 have been cancelled from the patent application, without prejudice in favor of a continuation patent application. The following Amendment supersedes the Reply filed by the Applicants on October 4<sup>th</sup>, 2007 in response to the outstanding Final rejection. Many of the arguments listed below repeat the arguments made in that Reply.

**1. Examiner's Interview of October 10, 2007**

Applicants thank Examiner Sharon for the courtesy extended to the Applicants where the Final rejection was discussed on October 10, 2007. The telephonic Examiner Interview was conducted with Jean-Paul Cass, Esquire, Mary Lou Wakimura, Esquire, and Susan G.L. Glovsky, Esquire. Applicants express appreciation to the Examiner for his detailed discussion, professionalism, comments, and devoting substantial time in order to resolve the outstanding issues in the subject patent application.

During the telephonic Examiner Interview, Applicants received some information concerning the outstanding rejection, and guidance. Applicants are now seeking to amend Claims 1-3, 8-13, 15, 17, 18-22, and 25-29 to remove the limitation "non-linear empirical process," and replace that limitation with the limitation "non-linear empirical industrial process" to overcome the rejection under 35 U.S.C. § 101. Support for the amendment of the claims can be found in various locations of the specification including at page 11, lines 3-9 of the patent application as originally filed, and at other locations. Additionally, Applicants are now cancelling Claims 31 through 64 in favor of placing those claims in a continuation patent application for examination to advance the prosecution and issuance of Claims 1 through 30. Lastly, Applicants thank the Examiner for discussing the patentable distinctions of Claims 1 through 30 in view of Steven Piché *et al.*, "Nonlinear Model Predictive Control Using Neural Networks" IEEE Control Systems Magazine, June 2000, pp. 53-62. Applicants believe that Claims 1 through 30 are patentable in view of the cited reference.

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Finally, Applicants note for the file wrapper that the instant Amendment is to be filed without an Request for Continued Examination; however, if the Applicants do not receive a Notice of Allowance or an Advisory Action by October 31, 2007, Applicants plan to file such a Request for Continued Examination by October 31, 2007. Applicants do not waive the right to file such a Request for Continued Examination by that date by filing the instant Amendment. The remainder of the remarks are substantially identical to those argued in the previously filed Reply dated October 4, 2007.

## 2. Improper Final Rejection

In the previous Office Action, Claims 1 through 5, 7 through 15, 17 through 21, and 25 were rejected under 35 U.S.C. § 103(a) as being unpatentable as obvious over United States Patent No. 5,877,954 to Klimasauskas, *et al.* (hereinafter "Klimasauskas") in view of United States Patent No. 5,477,444 to Bhat *et al.* (hereinafter "Bhat"). The Examiner stated at page 14 of the Action that Applicants' arguments regarding the Klimasauskas and Bhat references are persuasive and the 35 U.S.C. § 103(a) rejections are therefore withdrawn.

Turning to the final rejection at hand, the claims have been rejected primarily based on Steven Piché *et al.*, "Nonlinear Model Predictive Control Using Neural Networks" IEEE Control Systems Magazine, June 2000, pp. 53-62, which is a new ground for rejection. However, although the Office has entered a new ground for rejection, the Office has made the new rejection final. M.P.E.P. § 706.07(a) clearly provides that, "under present practice, second or any subsequent actions on the merits shall be final, except where the examiner introduces a new ground of rejection that is neither necessitated by applicant's amendment of the claims nor based on information submitted in an information disclosure statement filed during the period set forth in 37 C.F.R. §1.97(c) with the fee set forth in 37 C.F.R. §1.17(p)." Emphasis added.

In the Action at page 2, paragraph 6, the Office contends that, "Examiner's actions are necessitated by Applicants' amendment, and by Applicants' recently filed IDS. This action, therefore, is final." The Examiner is erroneous.

The specific information relied upon in the rejection is not newly cited, but a substantial portion of the teachings in Piché was before the Office in an information disclosure statement dated

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June 27, 2001, where the Applicants cited U.S. Patent No. 5,933,345 to Martin *et al.* (Piché is listed as a co-inventor).

The information of Piché is not newly cited, and, in fact, is substantially the same information taught in the '345 Patent already cited in an information disclosure statement dated June 27, 2001. The '345 Patent, and the Piché paper simply discloses a controller that uses a simple linear dynamic model with a quadratic transform. The neural net that is referenced is used purely to advise the controller what the model gains need to be adjusted to. The neural network is not used as a control model.

Accordingly, this new ground of rejection is not based on information submitted in an information disclosure statement filed during the period set forth in 37 C.F.R. §1.97(c) since the Piché publication is substantially the same information that was already provided to the Examiner on June 27, 2001 in the '345 Patent. Applicants contend that the instant office action should be a non-final rejection, not a final office action. Applicants respectfully request that the Office withdraw the finality of the rejection at hand.

### 3. Response to Examiner's Introductory Comments

Applicants respectfully seek to clarify the Examiner's comment on page 2 of the Action where the Examiner recites that "*contrary to Applicants' statement (see p. 29 of the amendment filed 6/11/07) that [the] application is not being examined, the IDS filed [on] 7/23/07 includes a final office action mailed in that application.*" On the date that the Applicants filed the Amendment, the new claims in the subject application of United States Patent Application Serial No. 10/842,157 to Sayyar-Rodsari *et al.*, (hereinafter "Sayyar-Rodsari") were not examined. Thereafter, on July 23, 2007, as the Examiner correctly notes, a final office action was mailed in that application. Therefore, Applicants' statement in the June 11, 2007 remarks was correct at the time it was made.

Immediately after receiving the final office action on the U.S.P.T.O. Public P.A.I.R. Image File Wrapper, Applicants notified the Office of the final office action in the Sayyar-Rodsari application via a supplemental information disclosure statement. At all times, Applicants fully disclosed the status of the copied claims to the Examiner, and the language "*contrary to Applicants' statement*" is unclear as it appears to suggest that Applicants' statement was incorrect at the time it

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was made. Furthermore, Applicants respectfully request that the Examiner clarify the statement for the record, or acknowledge that Applicants at all times disclosed the most current information to the Office.

4. **Allowable Subject Matter**

Applicants express appreciation for the indication that Claims 23 through 24 are allowed.

Applicants also note that Claims 6, 16, and 22 are indicated to include allowable subject matter, but stand rejected under 35 U.S.C. § 101. Applicants thank the Office for the indication of allowable subject matter in Claims 6, 16, and 22. Notwithstanding the indication of allowable subject matter, Applicants respectfully disagree with the 35 U.S.C. § 101 and other rejections and wish to traverse the rejection by argument as follows.

5. **Rejections under 35 U.S.C. § 101**

In the Action, Claims 1 through 22, and 25-64 are rejected under 35 U.S.C. § 101. The claims are rejected since the invention is supposedly directed to a mere abstract idea. Applicants must respectfully disagree. It is conceded that one may not patent an algorithm or a mere idea. See Gottschalk v. Benson, 409 U.S. 63, 71-72, 175 U.S.P.Q. 673, 676 (1972). Applicants are not seeking to claim the algorithm itself, or a mere idea. Applicants' claims not only require determining a computer implemented instruction plan for modeling a non-linear empirical industrial process but also for storing the result of execution of that instruction plan, or an analytically constrained model. These steps are clearly described in the preamble of Claim 1 as performed in a computer implemented method.

M.P.E.P. § 2106 provides that the claimed invention as a whole must be useful and accomplish a practical application. That is, it must produce a "useful, concrete and tangible result." See State Street, 149 F.3d at 1373-74, 47 USPQ2d at 1601-02. The purpose of this requirement is to limit patent protection to inventions that possess a certain level of "real world" value, as opposed to subject matter that represents nothing more than an idea or concept, or is simply a starting point for future investigation or research. See Brenner v. Manson, 383 U.S. 519, 528-36, 148 U.S.P.Q. 689,

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693-96 (1966); See also In re Fisher, 421 F.3d 1365, 76 USPQ2d 1225 (Fed. Cir. 2005); See also In re Ziegler, 992 F.2d 1197, 1200-03, 26 USPQ2d 1600, 1603-06 (Fed. Cir. 1993).

The computer implemented model of Claim 1 is constrained to provide for predictions of global behavior of a process and this prediction of global behavior is a useful, tangible, and concrete result. Moreover, this useful, tangible, and accurate result provides for a computer implemented method that can be used in regions of sparse initial input or in regions of missing initial input. Moreover, Applicants' method, not only has a tangible result, but also provides an additional tangible result where the prior methods do not. Specifically, Applicants' method may be used safely in a controller, while prior art neural nets are unsafe in a controller without prohibitive amounts of experimental data in order to empirically validate the safety of the model at every potential operating point. This is an additional tangible, and useful result, apart from the tangible result already recited in Claim 1.

First of all, the Applicants' method of Claim 1 includes a "useful, concrete and tangible result." See State Street, 149 F.3d at 1373-74, 47 USPQ2d at 1601-02. The claimed computer-implemented method for modeling a non-linear empirical industrial process includes creating a computer implemented initial model, which generally corresponds to the non-linear empirical industrial process to be modeled with the initial model having a base non-linear function, an initial input, and an initial output. The computer-implemented method further includes constructing a computer implemented non-linear network model based on the initial model. The non-linear network model has (a) multiple inputs based on the initial input and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output. In addition, this computer implemented constrained, non-linear model provides a tangible and physical result, namely reliable predictive global behavior in regions of missing or sparse input data, which the prior art does not.

Secondly, the Applicants' method of Claim 1 provides a useful, concrete and tangible result, where prior neural networks do not. This is an additional tangible result under State Street. The cited neural networks react very poorly in regions of missing or sparse input data, and have been ruled as "unstable" for use in a controller, which is implied in the claim limitation "the constrained model enabling precision control of the non-linear empirical industrial process." Applicants' computer implemented method reacts very well in such areas, and can be analytically guaranteed to

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be safe to use in a controller. See P. Lisboa, "*Final Report of the Task Force on Safety Critical Systems*," Page 6, <http://www.eunite.org/eunite/roadmap/12FinalReportSafetyCrti-1.pdf> which concludes "the difficulties with vanishing and inverting gains are a characteristic of the feed forward neural network and are better handled by other technologies such as fuzzy logic or models with analytically constrained gains."

Thirdly, the Office is erroneous at page 6, paragraph 20 of the present Action in stating that, "none of the rejected independent claims are restricted to any field of application, and therefore the claims are directed to all possible applications of the math recited in the claims." This is incorrect. In fact, the field of application is process modeling and process control, as indicated in Claim 1 (the constrained model enabling precision control of the non-linear empirical industrial process).

Moreover, on September 20, 2007, the United States Court of Appeals for the Federal Circuit issued an opinion in In re Comiskey, No. 2006-1286, slip op. at 18 (Fed. Cir. Sept. 20, 2007) that cited In re Diehr, 450 U.S. 175, 184 (1981), which states that the Supreme Court confirmed that a process claim reciting an algorithm could state statutory subject matter if it is (1)  tied to a machine  or (2) creates or involves a composition of matter or manufacture.

Applicants' Claim 1 recites a computer-implemented method for modeling a non-linear empirical industrial process. Clearly, the recitation computer-implemented method indicates that the algorithm is tied to a machine, and provides a useful, and tangible result. Since Applicants' claims are tied to a machine, Applicants' Claims are thus statutory, and patentable in view of In re Diehr. See In re Diehr, 450 U.S. 175, 184 (1981). Reconsideration and withdrawal of the 35 U.S.C. § 101 rejection are respectfully requested.

#### 6. Rejections under 35 U.S.C. § 102(a)

In the Action, Claims 1 through 5, 7 through 15, 17 through 21, and 25 through 64 are rejected under 35 U.S.C. § 102(a) as being anticipated in view of Piché. Claims 31 through 64 have been cancelled and the rejection to those claims is now moot. Applicants traverse the rejection by stating that Piché does not disclose or suggest all of the elements of the independent Claims.

Claim 1 recites creating an initial model generally corresponding to the non-linear empirical industrial process to be modeled with the initial model having a base non-linear function, an initial

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input, and an initial output. Claim 1 requires constructing a non-linear network model based on the initial model with the non-linear network model having (a) multiple inputs based on the initial input and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output and the global behavior being at least in regions of sparse initial input.

Claim 1 also recites calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients.

The global properties are used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior with the constrained model enabling precision control of the non-linear empirical industrial process.

Piché does not disclose or suggest calibrating a non-linear network model based on empirical inputs of a non-linear empirical industrial process by using a bound on an analytical derivative of a base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients. Piché also does not disclose or suggest that these global properties are used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior or that the analytically constrained model enables precision control of the non-linear empirical industrial process.

The control model in the Piché paper is a linear dynamic model (See equation 5 at page 56) or a quadratic model (See equation 9 at page 57). Piché does not disclose or suggest any constrained nonlinear approximator. A linear model and a quadratic model are not an analytically constrained non-linear network model. The only reference to a nonlinear (network) approximator in the Piché paper is the first equation on page 56 ( $y_{ss} = NN_{ss}(u)$ ).

Applicants submit that the first equation on page 56 of Piché discloses a standard neural network, which is described by D.F. Rumelhart, G.F. Hinton, and R.J. Williams, "Learning Internal Representations by Error Propagation" Parallel Distributed Processing, D. Rumelhart and J. McClelland Eds., Cambridge, MA, MIT Press, 1986, pp.318-362 at page 52 and in footnote 6.

First, Piché's standard neural network is not analytically constrained. A standard neural network is trained with no analytical constraints on the model derivatives. In addition, Piché merely

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uses the neural network to adjust coefficient values in the model in a supervisory manner (See equation (8) on page 56). Piché does not disclose an analytically constrained nonlinear network model, but instead, teaches a neural network model, which is a black box, and is unchanged. Applicants also remind the Examiner that a neural network of Piché cannot be analytically constrained so that the minimum and maximum input/output gains are guaranteed to be between a user specified upper and lower limit, since one of the gain limits in a standard neural network is always zero regardless of how it is trained. In other words, a neural network is not analytically constrained as claimed in Claim 1. It does not use an analytically constrained nonlinear network model, or construct such an analytically constrained nonlinear model as claimed in Claim 1. Piché's models are also not connected (*e.g.* in series like in an embodiment of the present disclosure). The neural network simply adjusts coefficients in the linear dynamic model.

Secondly, Piché does not disclose or suggest that the neural network is attached or connected to the second quadratic model, and thus does not disclose or suggest calibrating a non-linear network model as claimed in Claim 1. There is simply no connection between the neural network and the quadratic control model in Piché. The neural network is a separate, independent model that provides supervisory information to the coefficients of the second quadratic model. Piché's neural network is not constrained in anyway, and moreover, the neural network of Piché is not analytically constrained as claimed in Claim 1.

Claim 1 is directed to an analytically constrained nonlinear network model. Piché does not disclose an analytically constrained nonlinear network model. Instead, Piché discloses two separate, independent models. One is a standard neural network and the other is a quadratic dynamic model. Neither is an analytically constrained nonlinear network model.

Thirdly, Applicants also remind that Examiner that a neural network, such as disclosed in Piché cannot enforce global constraints because the minimum absolute gain is always zero, and the derivative will not globally match or generally correspond to the shape that will occur in a complex non-linear empirical industrial process. Thus, Piche also does not disclose or suggest calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical

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derivatives to be calculated directly from model coefficients. Accordingly, Applicants submit that Claim 1 is patentable over Piché.

Applicants believe that Claims 10, 11, 21 and 25 are patentable for reasons similar to those argued above for Claim 1. Claims 2 through 5 and 7 through 9 depend from Claim 1, and Claims 12 through 15 and 17 through 20 depend from Claim 11. Thus, these claims are patentable for at least the reasons discussed above for the base claims from which they depend. As such, the 35 U.S.C § 102(a) rejections of Claims 1 through 5, 7 through 15 and 17 through 21, and 25 are believed to be overcome and should be withdrawn.

In summation, Piché is no different than the 35 U.S.C. § 103(a) rejection of Klimasauskas, and Bhat, which disclose neural networks. Applicants submit that it was clear to the Examiner that the claims were patentable over Klimasauskas, and Bhat, and Piché is simply cumulative of those previously rejection, which have been already withdrawn. Reconsideration and withdrawal of the rejection are earnestly solicited.

Turning now to Claim 26, Piché also does not disclose or suggest manipulating the global maximum and minimum gain directly from the model coefficients. A standard neural net cannot manipulate global model gains as claimed (*i.e.* the minimum absolute gain of a standard neural network is always zero), and thus Claim 26 is patentable over Piché. Piché discusses changing the gain of the linear/quadratic dynamic model using the neural network but does not discuss analytically constraining the gains of the neural network to be within specified limits as this is not possible with a standard neural network.

Turning now to Claims 27, and 28, Piché also does not disclose or suggest that the model coefficients are manipulated by using a modified base non-linear function, or that the model coefficients are manipulated by using a modified base non-linear function that excludes at least one of a hyperbolic tangent function, a radial basis function, and a sigmoid function. Piché also does not further disclose or suggest that a base non-linear function has a global minimum or maximum first derivative that is independent of the model coefficients. Accordingly Claims 26 through 28 are patentable over Piché.

Turning now to Claim 29, Piché also does not disclose or suggest that the model coefficients are manipulated and that the global maximum and minimum values of the analytical derivatives are

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both a free function of the model coefficients. Thus, Claim 29 is also patentable over Piché. Claim 30 is patentable for at least the same reasons discussed above for Claim 29.

### CONCLUSION

In view of the above amendments and remarks, it is believed that all claims (Claims 1 through 30) are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

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